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ABSTRACT

This process model for individualized curriculum design and development is being used to produce extramural, self-instructional courses at the University of Pittsburgh. The model emphasizes curriculum analysis skills, making it particularly suited to complex subjects. It is an individualized, structured-curriculum model incorporating four additional components: a) content analysis procedures based on structure of the discipline to focus on process, b) samples of all skill levels to build independent learning capabilities, c) procedures for systematic application of research-based instructional strategies to instructional design, and d) procedures for incorporating independent inquiry into a structured model for instruction. (Author)

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INTRODUCTION

The Carnegie Commission on Higher Education (1972) has predicted that "off-campus instruction of adults may become both the most rapidly expanding and the most rapidly changing segment of post secondary education (p.4)." Because there are few self-instructional materials capable of meeting this need, they have urged that learning technology centers be established to engage in design, planning and production of instructional units for use by participating institutions and extra mural educational systems (pp. 55-56).

This paper describes a model used to develop and package curriculum design training materials and University of Pittsburgh External Studies courses. It suggests that the model would be effective and efficient for the production of the instructional units proposed by the Carnegie Commission. The training materials themselves would be appropriate to train personnel for the learning technology centers the Commission has advocated.

Called PIC or the Process Model for the Individualization of Curricula, the model combines structured curriculum design components with procedures for developing curricula which emphasize the structure of the discipline. These procedures focus on process by sampling in each unit all skill levels in order to promote the building of independent

learning capabilities; systematic application of research-based instructional strategies to the design of instruction; and use of independent inquiry within a structured model for instruction.

EVOLUTION OF THE MODEL

This curriculum model was developed at the Learning Research and Development Center at the University of Pittsburgh to provide curriculum design training materials and to train curriculum design specialists. The training was federally funded to help alleviate the well-documented shortage of trained personnel for R and D Centers (Chase, 1964; Clark and Hopkins, 1969; Gideonse, 1970).

Appropriately, since the LRDC had developed Individually Prescribed Instruction (IPI) and the Primary Education Project (PEP), both structured curricula, the design model selected for the training program was based on the structured or adaptive curriculum model. Lindvall and Cox (1969) have identified the components of this model as:

1. Sequences of instructional objectives to define the curriculum
2. Instructional materials to teach each objective
3. An evaluation procedure for placing each pupil at the appropriate point in the curriculum
4. A plan for developing individualized programs of study
5. A procedure for evaluating and monitoring individual progress.

Procedures developed for application of the structured curriculum model to social studies (Gow, 1972) were selected for the design of the curriculum training materials, with a self-instructional format

(Gow, 1972/73) which would allow students to assess their own needs and develop their own programs of study.

When the University of Pittsburgh inaugurated a pilot external studies project, a major part of these self-instructional materials became a post baccalaureate course in the design and development of curricular materials and the model for individualization of other University courses for extra mural, self-instructional studies. The PIC Model's content and component analysis procedures based on structure of the disciplines seemed to be uniquely suited to the complex subject matter of higher education, and the format was especially appropriate to meet the problems of extra mural education.

THE MODEL

The model, which evolved out of the efforts described here, is termed a Process Model for Individualization of Curricula to distinguish it from other structured curriculum models. While it is comprised of the usual structured-curriculum components and procedures (Gagne, 1965; Mager, 1962; Nitko, 1972; Bloom, 1956; Resnick and Wang, 1969) there are fundamental differences in the techniques for establishing instructional sequences and structuring hierarchies. In addition, there is a systematic attempt to apply the information we now have from the expanding field of instructional psychology to the design of curricula. The model itself is adaptive and provides a vehicle for the incorporation of new knowledge about the learning process as it is acquired.

The persuasive case for the teaching of the fundamental concepts and inquiry, to promote transfer and acquisition of intellectual skills, was made as far back as 1929 by Whitehead (p. 21) and 1938 by Dewey (p. 30), but it was Bruner's The Process of Education (1960) which had a major impact on the curricula created during the Reform Movement of the Sixties. In Bruner's words:

> "To understand something as a specific instance of a more general case ... is to have learned not only a specific thing, but also a model for understanding other things like it that one may encounter."
> (Bruner, 1960, p.25)

To know method, another element of structure, is to know how to find out more about a subject. The processes the student uses are the intellectual skills he needs if he is to acquire, organize and use the information fundamental to the discipline.

In addition, development of the concepts, which are elements of a discipline, is a process itself. Concept accommodation takes place as concepts become integrated into the student's frame of reference. Concepts grow and change instead of remaining static over time. Also, concepts are idiosyncratic because each individual's experience is unique. Individualized instruction based on concepts is therefore intrinsically individualized as well as adaptive to each student's needs.

Many quality curricula have been built on structure of disciplines in the past decade. (AAAS Science; BSCS Biology; SMSG Math; Taba Social Studies; Senesch Economics). Although Bruner seems to have become somewhat disenchanted (1971) with the ideas espoused by The Process of

Education, at least for the elementary and secondary years, his attitude apparently reflects a new concern for the importance of initiative and motivation to learn.

At the University level, however, discipline structure remains an essential consideration in curriculum design. Structured university education should focus on the processes which provide the student with the ability to learn independently. The PIC Model uses the fundamental concepts, principles, generalizations and methods of the discipline as the foundation for curriculum design and the basis for development of objective hierarchies and sequencing of instruction.

The Taxonomies of Bloom (1956) and Krathwohl (1964) are also used in the development of hierarchies. When curricula are analyzed, it is found that they seldom teach and test beyond the third level of Bloom's Taxonomy (Cox and Wildemann, 1970, pp. 24,26,38,42). Yet, we know that higher level skills transfer or facilitate learning (Gagne, 1971, p. 116; Bloom, et al., 1971, p. 122). The PIC Model, therefore, uses the Taxonomies as tools in the design process.

A further essential procedure to maximize the effectiveness of a structured-curriculum is the systematic application of research-based instructional strategies appropriate for the student, the subject matter and the objectives. The model borrows, pragmatically, from developmental, behaviorist or cognitive theory for selection of these strategies.

The Process Model prescribes structured curriculum components and describes procedures for building each component. The curriculum

designer is encouraged to establish his own procedural sequence, rather than follow a linear systems approach, because on-the-job experience has revealed that curriculum design is a highly complex and personal process. It involves backward steps to revise a previously written portion in the light of each forward step.

DESIGN PROCEDURES

It is in identifying the first component of the structured curriculum, sequences of instructional objectives to define the curriculum, that the PIC Model differes appreciably from most design procedures.

The PIC Model uses the usual content and component analysis procedures (Gagne, 1968) but adds to them: (a) concept analysis and (b) systematic sampling of skills.

Content is defined for this model as the people, information, events and data at the knowledge level (1.32 and below) of the cognitive Taxonomy. Content is selected because it represents the positive or negative instances of the basic concepts which are most appropriate for the student population and for the level of the instructional sequence based on our present knowledge of concept learning. A variety of concept instances may be identified making it possible for the specific content he will study to be chosen according to the individual student's interest. Instead of concepts being developed as a by-product of the study of content, the facts, events and data of content are used to encourage conceptualization. The focal point is the concept.

For an already existing course which is being individualized. the course outline provides the content scope and sequence. For a new course, it is necessary to do a content analysis, ordering the subject matter chronologically, by topic or by whatever logical organization the curriculum designer has selected.

The fundamental concepts of the discipline which the course teaches are identified. This process may be called a concept analysis since it identifies the concept hierarchy or inter-relationships of the conceptual structure. A concept analysis produces a hierarchy of sub-concepts, concepts, principles and generalizations for each unit of instruction.

To perform a concept analysis, the curriculum designer begins with a generalization and works backward asking what principles the students must know and be able to apply in order to understand this generalization. Then he asks what concepts he must know, and be able to identify examples of, in order to understand this principle. In this fashion, he works back to subconcepts that the student may be expected to know and be able to use. Often, specification of these elements of the discipline structure leads to addition of concept exemplars or reordering of content.

The PIC Model requires explicit identification of skills and methodology of the discipline and the use of Bloom's Taxonomy to select intellectual processes to incorporate into the course. The Taxonomy is used, in other words, to generate objectives. The process of

expressing the objectives of the course behaviorally involves expressly sampling higher taxonomic level skills.

The curriculum designer combines the products of the content and concept analyses, merging them with the selected skills and expressing the behavior in objectives which state what the student does , under what conditions and how well he does it (Mager, 1962). In constructing the instructional hierarchy, all of the following are considered: logical order of content and concepts, sequence of elements of discipline structure, and taxonomy levels of skills. To teach students the processes of learning, the intellectual skills and methods of the discipline are practiced on content and concepts.

In his early writings, Gagne used the terms "concepts" and "principles" in his hierarchies. Later, he changed concepts and principles to concept learning or classifying and applying rules or principles. The original use of these terms and the subsequent change reflect the problem which the PIC Model attempts to solve.

Concepts may be both knowledge and process. Therefore, they are inherently different from both content,as facts, events, people and data, and skills . When content includes concepts this dual function of concepts causes great difficulty in structuring hierarchies, especially when dealing with complex subject matter. By separating content analysis from concept analysis and component analysis this problem is eliminated.

The second component of a structured-curriculum, <u>instructional materials to teach each objective</u>, requires the curriculum designer to

use his teaching skills to move the student from his entering behavior to mastery of the terminal objectives of each lesson. It is in the degree of specificity of design strategies and the technique of recording the rationale for them, that the process model differs from most structured curriculum models.

The PIC Model requires that definition of each pedagogical decision of lesson writer be explicit. A planning form calls for listing of the objectives' prerequisite behaviors and the activities the student will participate in or tasks the student will perform. Most importantly, the lesson rationale defines and explains the method, mode, setting and instructional strategies used in the lesson. This requires a systematic examination of each element which must be matched to achieve maximally effective instruction.

The careful specification of strategies, and the systematic attempt to relate the lesson design to the requirements of the student and the subject matter and to justify that match by means of a lesson rationale eases formative evaluation procedures. It becomes possible to locate and change instructional strategies found to be ineffective, without altering other elements of the curriculum. The lesson rationale technique can facilitate evaluation of different strategies and development of more effective instructional materials.

The PIC Model does not differ appreciably from other such models in its procedures for development of the final three components of the structured curriculum: An evaluation procedure for placing each

pupil at the appropriate point in the curriculum; a plan for developing individualized programs of study and a procedure for evaluating and monitoring individual progress. It employs the usual criterion-referenced tests: diagnostic, placement, curriculum embedded or unit sub-tests and post-tests.

The model does, however, include a procedure for selecting testing points to make testing more efficient. By charting each unit objective hierarchy (Nitko, Swanson, 1968), it is possible to select the optimal testing points which can reduce the number of necessary tests. (See Appendix III). Since it can be assumed that mastery of earlier sequential objectives has preceded mastery of later ones, branch terminus objectives may, in many cases, be optimal testing points.

Sometimes there are two terminal objectives; one a cumulative or culminating objective and the other a synthesis objective. A cumulative objective is essentially the sum of all the other objectives. A synthesis objective goes beyond this to incorporate the student's own perspective, solution or organization of the knowledge and skills of the hierarchy. The decision on whether to test one or both or whether to demand mastery of both, depends on diagnosis of the student's present requirements. For example: Suppose a student were studying social studies and there were two sequential objectives at the top of a charted unit hierarchy. He mastered the first which was cumulative, but could not master the final objective which required him to formulate a generalization. More examples of the concept in additional optional materials might lead him to the

generalization, or it might be deferred until his next encounter with the concept. (See Appendix IV)

Finally, the PIC model, because it is a process model, can be used to produce structured curricula written in advance of the instructional event and still feature open-ended individual inquiry as a possible design option. Since the focus is on processes, and instruction is carefully sequenced and written to teach process, criteria can be established for unique responses resulting from independent research or creative production. The product can be evaluated in terms of the evidence it provides of the processes used to produce it. Self-evaluation can be accomplished by use of criteria and process check-lists.

THE FORMAT OF THE CURRICULUM COURSE

Each unit of the curriculum course based on the PIC model includes objectives, a charted objective hierarchy, study guides, answer keys, an overview, pertinent reprints of journal articles, a bibliography and a post-test. Although the format is particularly suited to mature students capable of self-direction, it can be used for instruction at any grade level, including computer assisted or teacher or aide monitored instruction, since all components of the instructional package are cross-coded. Curriculum-embedded test items, study guide tasks and sources for these tasks are coded to the objectives.

Students are guided in their choice of objectives by the pretest and their own aims. Individual differences among extra mural students may be expected to be greater than among university undergraduates or

graduate students. Therefore, the pretest directs students to remedial units and permits them to "test out" of units they do not need. Additional sources, listed in the bibliography, can be used to remedy deficiencies in comprehension or skill revealed by failure to master test items or study guide tasks.

This format makes it possible for the student to determine his own placement in the program, plan his own program of study and monitor his own progress.

INDIVIDUALIZED APPLICATION OF THE MODEL

The curriculum course which teaches the design model described in this paper also teaches the instructional theory on which the PIC model is based. The procedures for designing curriculum components range from simple procedures to convert a traditional course to an individualized one to highly complicated procedures for creating an adaptive instructional environment. Knowledge of the theoretical basis for the design of instruction makes it possible for the student curriculum designer to make an informed judgment about the degree of structure he needs and wants to incorporate in his course and to selectively study as much as he needs to know to accomplish those ends.

For example, the instructional designer who will be employed at an R and D Center would need to learn some of the highly sophisticated techniques for validating instructional hierarchies, while this might not be necessary or feasible for university professors who cannot devote

considerable time to individualization of their courses. Imposing these techniques on teachers and curriculum specialists in schools might discourage further efforts towards structuring effective individualized curricula. Rather, hierarchies can be considered tentative until empirically validated. An advantage to this latter stance is that it reinforces the attitude that curriculum development is a process and curricula are revisionary rather than static.

SUMMARY

The predictions and recommendations of the Carnegie Commission on Higher Education of the trend toward off-campus instruction of adults and the need for design of instructional units to meet the expected expansion suggest that a model is needed for the complex subject matter of the university. Such a model would contribute to the effectiveness and efficiency of higher education and particularly of extra mural adult education.

The Process Model for Individualizing Curricula (PIC) described in this paper, focuses on the structure of disciplines which make it appropriate for complex university-level content. Its trial run as a graduate course, developed by using the processes it teaches, has shown its effectiveness for teaching learning and instructional theory as well as applied curriculum design skills. This seems to support its usefulness for both theoretical and applied courses.

The highly structured unit design and self-instructional format

recommend the total design package for use in in-service teacher training and for master's and doctoral programs as well as for teaching extra mural university curriculum design in any field.

APPENDIX I

PROJECT TO DESIGN NEW PATTERNS FOR TRAINING R&D PERSONNEL IN EDUCATION:
CURRICULUM DESIGN AND DEVELOPMENT PROJECT

Course Outline: The Design of Individualized Instructional Curricula

Background to Instructional Design

I. Goals of Education

- A. Goal-setting
- B. The Reform Movement
- C. Individualization of Instruction

II. Psychological Bases of Instruction

- A. Learning Theories
- B. Instructional Theories
- C. Behavior Management

Theoretical Rationale for Instructional Design

III. The Subject Matter

- A. Structure of the Discipline
- B. Content Analysis

IV. The Skills

- A. Behavioral Objectives
- B. Taxonomies
- C. Component Analysis

V. The Instruction

- A. Instructional Methods and Strategies
- B. Media
- C. Classroom Environment

VI. Evaluation

- A. Formative
  - Feedback
  - Field Testing
  - Dissemination
- B. Summative

VII. School Organization

A. Administrative Theory and Practice

B. In-Service Teacher Training

Applied Instructional Design

VII. The Design of Instruction

A. Design Procedures

B. Specification and Structuring of Objectives

C. Criterion-Referenced Test Construction

D. Selection of Instructional Methods, Media, Strategies and Setting

E. Lesson Writing

F. Management System Design

Curriculum Synthesis

IX. Instructional System Development Project

APPENDIX II

External Studies Course: Design and Development of Curricular Materials I.
(A Process Model for Individualization)

Theoretical Rationale for Instructional Design

I. The Subject Matter

Study Guide 1. Structure of the Discipline

Study Guide 2. Content and Concept Analysis

II. The Skills

Study Guide 1. Behavioral Objectives

Study Guide 2. Taxonomies

Study Guide 3. Component Analysis

III. The Instruction

Study Guide 1. Adapting Instruction to Learner Characteristics

Study Guide 2. Instructional Methods, Media and Strategies

Study Guide 3. Classroom Environment

IV. Evaluation

Study Guide 1. Formative and Summative Evaluation in Curriculum Design

V. School Administration and In-Service Training

Study Guide 1. Administration

Study Guide 2. In-Service Training

Design and Development of Curricular Materials, II.

Applied Instructional Design

I. Design Procedures

Study Guide 1. Individualization Procedure Analysis

Study Guide 2. Personalized Procedures

II. Specification of Objectives and Structuring of Hierarchies

Study Guide 1. Identifying and Writing Objectives

Study Guide 2. Structuring and Charting Hierarchies

III. Criterion-Referenced Test Construction

Study Guide 1. Writing Test Items

Study Guide 2. Sampling Objective Domain and Assembling Tests

IV. Selection of Instructional Methods, Media Strategies and Setting

Study Guide 1. Individualized Instruction

Study Guide 2. Constructing Lesson Rationale

V. Lesson Writing

Study Guide 1. Implementing Selected Strategies

Study Guide 2. Concept Learning

Study Guide 3. Inquiry

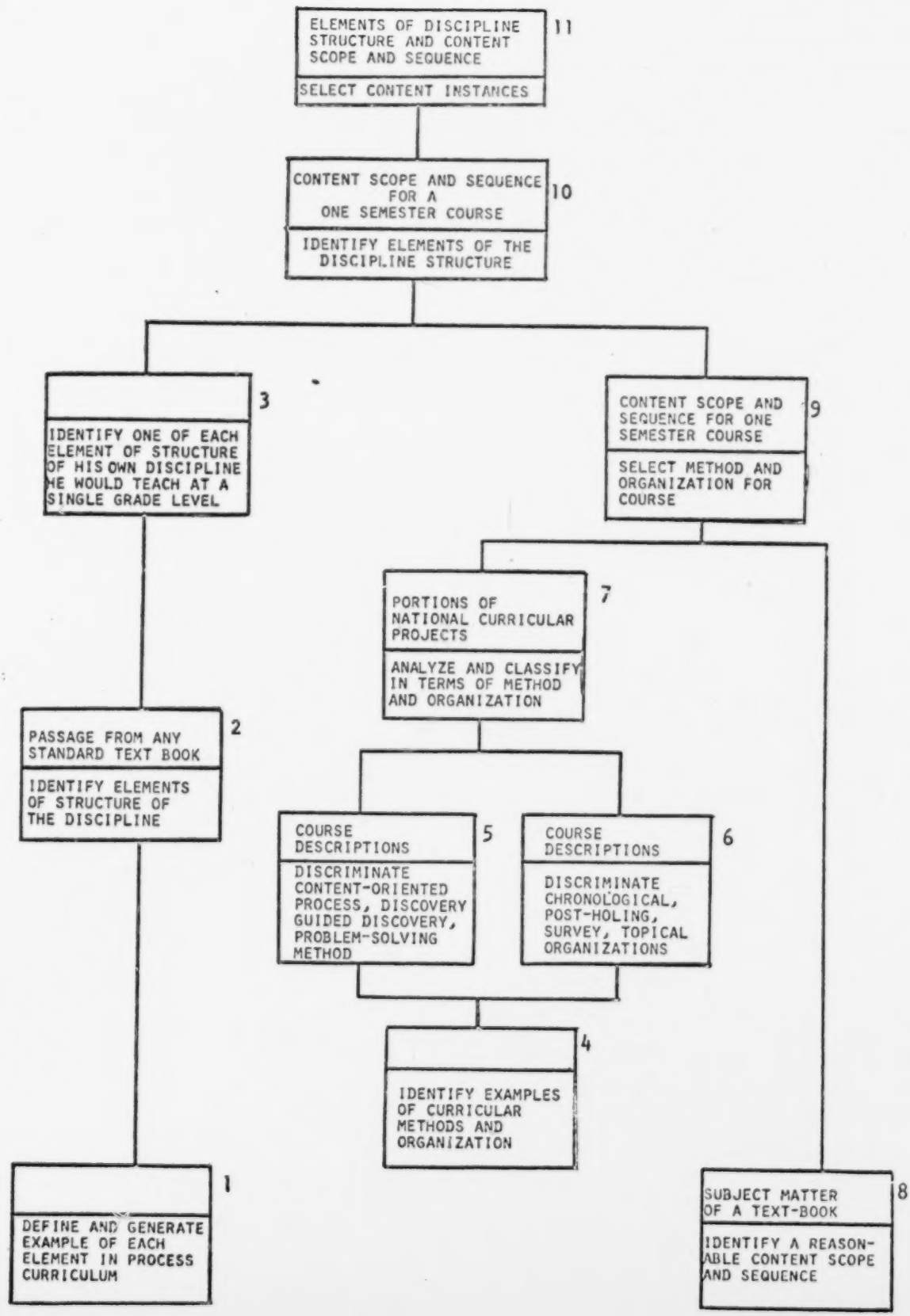
VI. Management System Design

Study Guide 1. Feedback System

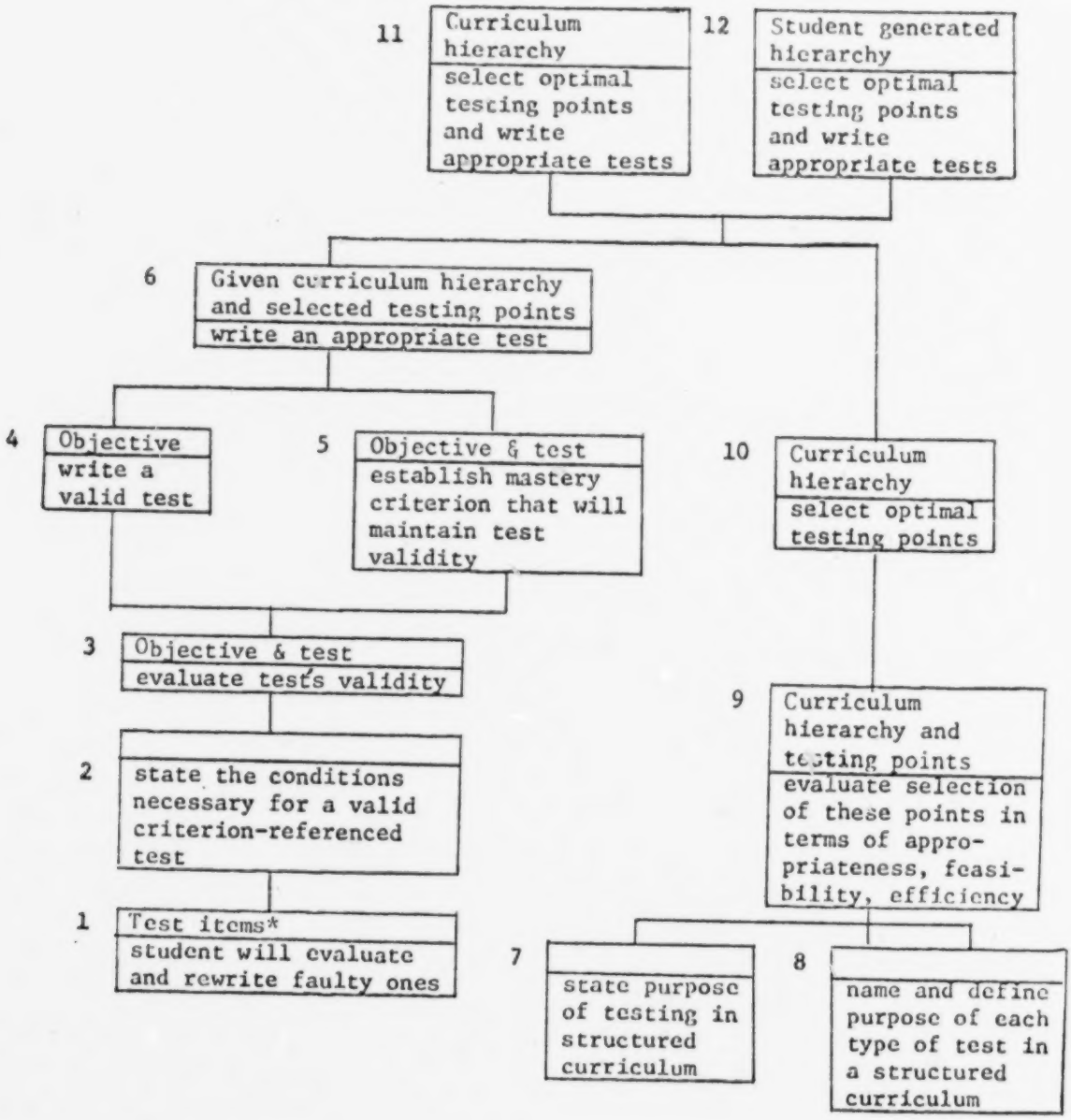
Study Guide 2. Staff Planning

APPENDIX III
Examples of Charted Hierarchies

D. HIERARCHY


ELEMENTS OF DISCIPLINE STRUCTURE AND CONTENT SCOPE AND SEQUENCE
11
SELECT CONTENT INSTANCES
CONTENT SCOPE AND SEQUENCE FOR A ONE SEMESTER COURSE
10
IDENTIFY ELEMENTS OF THE DISCIPLINE STRUCTURE
3
IDENTIFY ONE OF EACH ELEMENT OF STRUCTURE OF HIS OWN DISCIPLINE HE WOULD TEACH AT A SINGLE GRADE LEVEL
CONTENT SCOPE AND SEQUENCE FOR ONE SEMESTER COURSE
9
SELECT METHOD AND ORGANIZATION FOR COURSE
PORTIONS OF NATIONAL CURRICULAR PROJECTS
7
ANALYZE AND CLASSIFY IN TERMS OF METHOD AND ORGANIZATION
PASSAGE FROM ANY STANDARD TEXT BOOK
2
IDENTIFY ELEMENTS OF STRUCTURE OF THE DISCIPLINE
COURSE DESCRIPTIONS
5
DISCRIMINATE CONTENT-ORIENTED PROCESS, DISCOVERY GUIDED DISCOVERY, PROBLEM-SOLVING METHOD
COURSE DESCRIPTIONS
6
DISCRIMINATE CHRONOLOGICAL, POST-HOLING, SURVEY, TOPICAL ORGANIZATIONS
4
IDENTIFY EXAMPLES OF CURRICULAR METHODS AND ORGANIZATION
1
DEFINE AND GENERATE EXAMPLE OF EACH ELEMENT IN PROCESS CURRICULUM
SUBJECT MATTER OF A TEXT-BOOK
8
IDENTIFY A REASONABLE CONTENT SCOPE AND SEQUENCE

D. Hierarchy



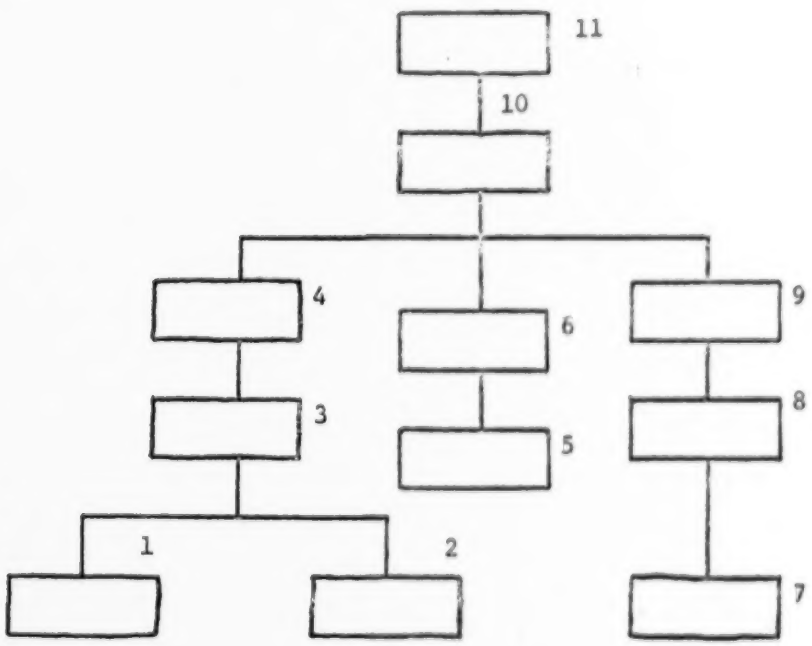
(Prerequisite, Unit II, Objectives)

*Multiple choice, true-false, short answer, matching, essay.

APPENDIX IV

NOTE: The following example of optimal testing points shows the structure only, not the specific objectives, in order to emphasize the general principle. This is done because, in specific instances, the testing points are a matter of judgment based on the objectives themselves. However, the optimal testing principle, used with discrimination, can increase testing efficiency.

Hierarchy and Testing Points



For pretest 4, 6, 9.

For CETs 4, 6, 9.

For post-tests 10, 11 or just 11.

For placement 1, 2, 4, 6, 7, 9.

Explanation

The testing of 4, 6 and 9 for the pretest would narrow the options sufficiently to be an economical procedure. If the student failed 4 he would start in 1. If he mastered 4 and 6, and failed 9 he would start in 7. If he mastered 4, 6 and 9, he would be given the post-test.

The CETs would be given for 4, 6 and 9 because they represent 3 different sub-hierarchies. Giving 10 would not indicate which of these 3 he had failed to master.

The post-test need only be on the final objective if it is a cumulative objective which demands behavior that is essentially the sum of all the other objectives. However if 10 were cumulative and 11 went beyond to synthesis, it might be wise to test both 10 and 11 to ascertain whether the student had mastered everything to and including 10. If he had, but failed 11, he would probably profit from more practice with different materials rather than repetition of the same lessons, or the final synthesis objective might be deferred.

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